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3420 Pest Management Evaluation
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Forest Pest Evaluation of Thomas Mountain Recreation Area, San Jacinto Ranger District, San Bernardino National Forest

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Introduction

On March 20, 1995, Merri Carol Murray, Forester, San Bernardino National Forest, and Laura Merrill, FPM entomologist, visited Thomas Mountain to evaluate forest health. They were joined by Ed Arredondo, a logger working on the site. On November 29, 1995, Kathy Valenzuela, Resource Officer, San Jacinto Ranger District, and James Allison, FPM pathologist, visited Thomas Mountain to collect forest disease information.

The management objective for this area is primarily recreational, and the area includes three developed campgrounds as well as yellow post sites and dispersed recreation. The District is implementing vegetation management on the site, following a 1992 prescription by Ernie DelRio, then Forest Silviculturalist. This prescription called for reducing stocking level where appropriate, planting in openings, as appropriate, controlling gophers, and retaining older trees. The District requested an FPM evaluation to more effectively implement the silvicultural prescription. The District would like a healthy stand, and wants to remove topkilled white fir while it is still merchantable.

The timber stand is limited by moisture, soil depth, gophers (Hamilton et al. 1991), and other biotic agents.

Observations

The overstory is primarily Jeffrey pine, Jeffrey-Coulter hybrid, Coulter pine, white fir, incense-cedar, California black oak, and live oak. Both the pines and fir had topkill. The topkill in the pine was old, but fresh topkill was occuring in the fir. The white fir tops were infested with Scolytis ventralis, the fir engraver, and the boles had extensive heart rot. The fir was also infested with true mistletoe (Phoradendron bolleanum ssp. pauciflorum). Ed Arredondo felled two white firs for our inspection. The first tree was ca. 16 inches (40 cm) dbh, and the top half was dead and had been attacked by S. ventralis. The tree was also under attack by roundheaded borers (Coleoptera: Cerambycidae). Sections of the trunk were taken to the Riverside Fire Lab and caged, and large numbers of Xylotrechus albonotatus emerged. These roundheaded borers are secondary agents which may cause

economic losses to lumber, but which do not attack and kill healthy trees. The second tree, ca. 30 inches (75 cm) dbh, also had a dead top, abandoned S. ventralis galleries (along with many exit holes), and mistletoe in the crown. Heart rot was not visible in the base of either tree, but was present further up the stems.

Ed also felled a topkilled Jeffrey pine, which was under attack by Ips sp. Sections of the trunk were taken to the Riverside Fire Lab and caged. Large numbers of Eucrossus villicornis (Coleoptera: Cerambycidae) were reared from these bolts. For example, 24 individuals emerged from one bolt which was 20 inches (52 cm) long and 12 inches (30 cm) in diameter. Two individuals of Dicerca tenebrosa (Coleoptera: Buprestidae) and three Temnochila sp. (Coleoptera: Trogositidae), a predator of bark and wood boring insects, also emerged from the bolts. Although the California flatheaded borer, Melanophila californica, was not observed in this brief visit and did not emerge from the log sections which were taken to Riverside, it is likely to be present in Jeffrey pine in this area.

In addition to high populations of true mistletoe on fir, as noted above, James Allison also observed scattered plants of incense-cedar mistletoe, Phoradendron juniperum ssp. libocedri. This parasite appeared to be having minimal effect on the health of the stand. Infections levels of oak mistletoe, P. villosum, ranged from light to severe. The true mistletoe on fir was causing tree deformation, reduced vigor, and was contributing to the top kill of infected trees by Scolytus ventralis. Jeffrey and Coulter pines, as well as their hybrids, have high populations of western dwarf mistletoe, Arceuthobium campylopodum.

One annosus root disease center was found. Fungal conks were found in a 38" (97 cm) diamter Jeffrey pine stump. Six dead and dying incense-cedars, 6" - 20" (15 - 51 cm) dbh, surrounded the stump.

Information on the biologies of these pests is given in the appendix. Note: insects were identified by LDM and have not been sent to specialists for confirmation.

At the time of the site visit, management action consisted of felling hazard trees within 200 feet (60 m) of the road.

Pest Management Alternatives

1. No Action. Western dwarf mistletoe will have a significant impact on the trees on Thomas Mountain. Pine mortality and lack of pine regeneration will be the two primary impacts on recreation and visual resources. Dwarf mistletoe will increase in intensity in Jeffrey and Coulter pines already infected and will spread to surrounding susceptible Jeffrey and Coulter pines. It will also intensify in individual trees as vertical spread exceeds the rate of height growth of many of the trees. The more heavily infected trees will have increased susceptibility to successful bark beetle and borer attack. Overmaturity, overstocking, compaction, and periodic drought will increase this susceptibility. Understory pines will be severely affected as they are annually exposed to additional infection from overhead. Height growth will be limited, as will the value of the trees as

future replacements. Loss of the pines from the overstory will release the more shade-tolerant white fir and incense-cedar in the understory, resulting in a changed vegetative condition. The increased size of these tolerant trees, expecially the white firs, will result in a greater hazard potential because of the increased susceptibility of white fir and the hazard of root infection by H. annosum. (Note that the white fir strain of H. annosum was not found on Thomas Mountain during the course of this evaluation.)

Annosus root disease centers will continue to expand in most cases. Because of underground nature of the fungus, our inability to know its exact location in root systems, and the intertwining of the surrounding root systems, we cannot predict where, or if, additional infection and mortality will occur around existing centers. Most disease centers last several decades and slowly expand outward at a rate of 1-2 feet per year. When non-susceptible species are encountered, such as black oak and brush species,outward spread of the fungus is usually curtailed. Conifer regeneration within root disease centers is often killed as a result of infection by the fungus. Expanding openings usually develop that are vegetated by grasses and brush species which serve as good habitat for pocket gophers.

True mistletoe in white fir will cause problems in some infected trees as infections increase. The height growth of the infected understory may be so impaired that it will have a difficult time reaching the overstory.

True mistletoe will continue to spread in the oaks. As it is carried from tree-to-tree, mainly by birds. Trees heavily infected by mistletoe are weakened,have reduced growth rates, and are sometimes killed.

The fir engraver, Scolytus ventralis, will continue to cause damage in white fir under drought stress or infected with true mistletoe or other insect and disease pests. Pine engravers, Ips. spp., will continue to attack live pine trees which are suppressed or stressed by dwarf mistletoe, root disease, drought, fire, or the attack of other insects. In addition, if fresh slash is available in the spring, pine engravers may buildup in an area and cause mortality or top killing by mid-summer. The California flatheaded borer, Melanophila californica, may also kill stressed or decadent trees. Secondary flatheaded and roundheaded borers will degrade lumber in trees killed by other agents.

2. Reduce the impact of Annosus Root Disease. Once annosus root disease is established in a stand, no direct control is available. Control, therefore, involves preventing of new centers and decreasing the risks of stump infection, and silvicultural manipulations of infected stands to minimize the effect of the disease. The following alternatives are available:

a. Prevent stump infection. Application of granular borax to freshly cut coniferous stumps is effective in preventing most new infections. The chemical is toxic to spores of H. annosum, but has no effect on existing infections.

b. Plant and favor hardwoods or resistant conifer. Revegetation of active annosus centers should be done only with resistant species. Leaving the

centers barren or planting them with resistant hardwoods or conifers will result in the fungus eventually dying out so the susceptible trees can once again be successfully established. Unfortunately, this will likely take 50 or more years. Favoring the oaks already present and planting suitable hardwoods, conifers, or shrubs will provide shade as well as establish a barrier of nonsusceptible roots that may limit the spread of annosus centers.

c. **Thinning.** Thinning will increase tree vigor and thus reduce the risk to disease and insects. Thinning dense stands of conifers will maximize opportunities for root contact and subsequent spread of H. annosum. Stumps created during thinning should be treated with borax and slash created should be chipped, burned, removed from the site or lopped and exposed to the sun to minimize engraver buildup. Removal of white fir heavily infected with mistletoe will increase stand vigor.

d. **Patchcuts.** This would be similar to thinning, accomplishing sanitation, stocking, and species control. In heavily infected areas, patchcuts could be regenerated with brush species and oaks, thereby meeting wildlife objectives. Patchcuts would probably need to be no more than 1/2 acre in size.

3. **Reduce the impact of Dwarf Mistletoe.** Several alternatives for reducing the impact of dwarf mistletoe in recreation areas are available. FPM funding may be available for approved dwarf mistletoe control projects. Remove or prune trees according to the guidelines listed below:

Control Alternatives

Dwarf Mistletoe treatments may include one or any combination of the following:

1. Removing infected overstory trees to protect regeneration.
2. Removing witches' brooms to prolong tree life.
3. Removing all infections by pruning to eliminate the parasite.
4. Removing heavily infected trees that cannot be successfully pruned.
5. Thinning to remove infected trees and release residual trees.
6. Destroying heavily infected stands or aggregations and then regenerating.
7. Creating buffer strips to prevent re-entry of dwarf mistletoe.
8. Favoring resistant species (includes planting).

The objective of any pest management activity in a Recreation Area should be to promote the growth of healthy and vigorous all aged, mixed species, properly stocked stands. The integration of suppression and prevention methods into the long-term management of the Recreation Area is necessary to completely fulfil this objective.

4. **Reduce losses to insects.** Two groups of insects were found to be causing problems on Thomas Mountain: the opportunistic tree killers such as Ips spp., Scolytus ventralis and Melanophila californica (the latter, though not observed on this visit, is undoubtedly present in the area), and the scavengers, such as the two species of roundheaded and one species of flatheaded borers reared from pine and fir logs.

   Maintaining a healthy, vigorously growing stand and practicing good sanitation (i.e., slash removal) will reduce losses to the opportunistic tree killers. Stocking control, mistletoe control, and managing for root disease will enhance the vigor of the trees, increasing their ability to pitch out attacking beetles.

   Scavenger beetles which bore in the wood of dead and dying trees are not a concern from the perspective of forest health, but reduce the value of sawlogs. When trees are sold as sawlogs, prompt removal and milling of dead and dying trees will reduce losses to roundheaded and flatheaded borers.

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APPENDIX: Biologies of Pest Organisms

Annosus Root Disease of Pine

Heterobasidion annosum is a fungus that attacks a wide range of woddy plants, causing decay of the roots and lower bole and death of sapwood and cambium. All pines in California are susceptible. Madrone(Artemisia menziesii), red alder(Alnus rubra), California live oak(Quercus agrifolia) and a few brush species, Manzanita(Arctostaphylos sp.) and sagebrush(Artemisia sp.) have also been found infected.

H. annosum in western North America consists of two intersterility groups or biological species, the 's' group and the 'p' group. These two biological species of H. annosum have distinct differences in host specificity. To date, all isolates of H. annosum from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense-cedar, western juniper, pinyon, and manzanita are all from the 'p' group. Isolates from true firs and giant sequoia are of the 's' group.

Local spread of H. annosum outward from a stump results in the formation of disease centers that have dead trees in the middle and dying trees on the margin. These centers usually continue to enlarge until they reach barriers such as openings or groups of non-host plants. The fungus may remain alive for as long as 50 years as a saprophyte in infected roots and stumps. Pines may seed in or be planted in centers and survive for a few years, but they will be infected and die.

Western Dwarf Mistletoe

Western dwarf mistletoe(Arceuthobium campylopodum) infects principally ponderosa, Jeffrey, and knobcone pines, and occasionally Coulter and lodgepole pines. This parasite is a flowering plant which aquires its nutrients and water from its host. It requires living host tissue to survive.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and seeds are forcible discharged. The seed is covered with a sticky substance. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seed is limited to the distance the seeds are discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occasionally vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. In Jeffrey pines, the average annual vertical rate of spread is 4-6 inches.

Dwarf mistletoes are easy to indentify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swelling, witches' brooms in the lower crown, and bole swellings.

White Fir True Mistletoe

White fir true mistletoe, Phoradendron bolleanum ssp. pauciflorum, is a true mistletoe having small, green leaves and round, white berries. It can only survive in living white fir tissues, principally as a water parasite utilizing water and minerals from the host. In california, it is limited geographically to the Sierra Nevada south of Interstate 80, and to the mountains of southern California.

This pest is spread mainly by birds, including robins, bluebirds,thrushes, phainopeplas, and cedar waxwings. Birds feed on the berries, digest their pulp, and excrete the living seed, often depositing them onto susceptible trees. A viscous coating and hair-like threads on the outer surface of the seeds attach them firmly to twigs and branches, where they germinate and infect host tissues.

Heavily infected trees are weakened, reduced in growth rate, and sometimes killed. Weakened trees are predisposed to attack by insects and often die during drought or other periods of stress. Severe infection of white fir can result in top-kill in combination with the fir engraver(Scolytus ventralis). Branches and tree tops heavily-laden with true mistletoe often break during wind storms, increasing the hazard to people and property in campgrounds and other developed sites.

White fir mistletoe is recognized by the clumps of mistletoe foliage in the tree. These mistletoe plants are usually in the tops of larger. older trees.With several infections, virtually all of the tree's foliage may be replaced by mistletoe plants. Dead spike tops are common in white fir stands heavily infected by this parasite.

True Mistletoes on Oaks

True mistletoes(Phoradendron spp.) are generally less demanding of their hosts than the dwarf mistletoes, yet can be serious pests where individual trees are of high value, as in yards, parks, and campgrounds.

Some species of true mistletoe grow on only a single genus of trees; others occur on a wide range of hardwoods. Although they are completely parasitic, they manufacture many of their nutrients by photosynthesis and usually require only water and minerals from their hosts. However, if the green aerial shoots

of the mistletoe are removed, the root system of the parasite can utilize the host's nutrients and remain alive within an infected branch for years.

Mistletoe infections are spread mainly by birds- including robins, bluebirds, thrushes, and cedar waxwings -that feed on the berries. Birds digest the pulp of the berries and excrete the living seeds, often depositing them onto susceptible trees, A viscous coating and hair-like threads on the outer surface of the seeds attach them firmly to twigs and branches, where they germinate and infect the host tissue.

Young or small trees are seldom infected by leafy mistletoe. In nearly all cases, initial infection occurs on the tallest and oldest trees because birds prefer to perch in their tops. Severe buildup of mistletoe often occurs in an already-infected tree because birds are attracted to and may spend prolonged periods feeding on the mistletoe berries.

Trees heavily infected by mistletoe are weakened, have reduced growth rates, and are sometimes killed. Branches heavily with mistletoe often break during storms or high winds, and trunk swellings may provide an entrance point for decay fungi, further increasing the hazard to people and property in campgrounds and other developed sites.

The true mistletoe on hardwoods on Thomas Mountain occur on both evergreen and deciduous oaks(Phoradendron villosum). Mature leaves are somewhat stiff and hairy, and are approximately 0.6- 1.8 inches long by 0.4- 0.9 inches wide.

Fir Engraver

The fir engraver attacks Abies concolor, A. grandis, A. magnifica, Pseudotsuga menziesii, Tsuga, and Picea in much of western North America. This insect is a major pest of true firs, attacking pole size to mature trees. The fir engraver is particularly damaging in trees under drought stress or infected with annosus root disease or other insect and disease pests. The fir engraver may breed in slash or windthrow. Slash has not been shown to be a problem with respect to management of this insect, but good sanitation is always advisable where feasible.

Broods often develop without killing the tree. The infested part of the phloem often heals over, leaving a pitch pocket where the brood galleries had been.

The .16 inch (4 mm) long adults create egg galleries perpendicular to the grain, deeply scoring the sapwood. Eggs are laid on either side of the egg gallery, and larval mines are tunnelled parallel to the grain of the tree. In most of its range, the fir engraver has one generation/ year, although in colder regions development may require 2 years. This insect does not form pitch tubes, but boring dust may accumulate in cracks in the bole.

For many reasons, including the presence of brood in healthy trees, direct control of this insect is not feasible. Management should be directed at maintaining a vigorously growing stand through stocking level control and management of other fir pests.

Pine Engraver Beetles

Pine engraver, Ips spp., attacks have been recorded on most species of pines in California. These beetles kill saplings, poles and sawtimber up to about 26 inches (66 cm) dbh and the tops of even larger trees. Attacks on live trees are usually limited to trees which are suppressed, or stressed by dwarf mistletoe, root disease, drought, fire or the attack of other insects. If fresh slash is available in the spring, pine engravers may build up in an area and cause localized mortality or top killing by mid-summer.

Attacks are made with the coming of warm weather in the spring. Attacking males bore nuptial chambers in the inner bark and release a pheromone which attracts other beetles to the attack site. If many beetles are attracted, they may attack nearby trees and cause a group kill. Within a day or two of the attack by the male, two to five females enter the nuptial chamber and after mating, each female bores an individual egg gallery which lightly scores the sapwood. The size and pattern of the combined gallery pattern is often diagnostic of the species of Ips involved. The galleries are kept open by beetles pushing boring dust out through the entrance hole. Red boring dust collecting in bark crevices or spider webs is diagnostic of a successful attack. Eggs are laid in niches along the sides of the galleries. Larvae hatch from the eggs and feed in the phloem. They eventually pupate in cells at the end of their larval mines and transform to adults.

A new generation is produced in as little as 6-8 weeks in the spring to 4-6 weeks in mid-summer (August). Thus, several overlapping generations per year may be produced. The winter may be passed in any of the life stages of larvae, pupae, or adults, depending upon which Ips species is involved.

Outbreaks in standing, healthy trees are sporadic and of short duration, and are often associated with some temporary stress or shock afflicting the host species, such as drought or logging disturbance. Tree killing frequently occurs where green pine slash, which serves as breeding habitat, is left untreated during spring and summer. To be suitable as pine engraver breeding habitat, pine slash must have bark from 1/8 to 1 inch (.3 - 2.5 cm) thick (usually 3 to 26 inches [8 - 66 cm] diameter), must have succulent phloem and must remain moderately cool during the development period.

Fresh pine slash caused by thinning, dwarf mistletoe control work, construction or winter storm breakage can be modified in a number of ways to make it unsuitable for pine engraver breeding. One approach to minimizing damage is to schedule slash-generating activities mostly between mid-July and late-December, when the slash has a high probability of drying out, heating up, or spoiling before the beetles can complete their development. Utilization of the cut material to the smallest possible diameter will minimize the amount of breeding material available to engraver beetles. If green pine slash must be created during the spring and early summer, slash treatments are avalable to prevent the buildup of pine engraver populations. Because pine engravers can complete their development in about a month under ideal conditions, treatment should be carried out soon after cutting to be effective.

Slash treatment methods which generally work well include chipping, lopping and scattering slash in sunny areas to heat it up, crushing or mashing slash with logging equipment to make it unsuitable for pine engraver breeding, or

piling and burning the slash within a month of cutting. Broadcast burning the slash might work if it could be done without damaging the residual stand. A method which has worked during the summer in hot climates is to pile slash in a sunny area and tightly cover the pile with clear plastic. If the temperature under the bark of slash in all parts of the pile reaches 120°F, all brood currently in the pile will be killed. Lower temperatures will not be effective and, where successful, this method will not prevent reinfestation of slash piles. Because most pine engraver attacks occur within a quarter-mile from the location where the beetles emerged, high value pines can be given some protection by removing fresh pine slash to areas which do not have pines.

Two practices which should generally be avoided are piling fresh pine slash without further treatment, and allowing slash to touch or remain near valuable leave trees.

California Flatheaded Borer

The California flatheaded borer, Melanophila californica, principally attacks Jeffrey and ponderosa pines, although it may be found in other pines including Coulter and knobcone pines.

It is most severe in stands located on sites where environmental stress is common. Decadent or unhealthy trees are most frequently attacked, along with an occasional top of a thrifty, vigorous tree.

Eggs are laid in bark crevices of the host tree. Newly hatched larvae penetrate directly through the bark to the phloem. Here the larvae may feed from a few months to 4 years without any apparent effect on the host tree. Should host vigor and larval abundance not allow them to succeed, the larvae cut very short galleries before they die. These galleries do not seriously injure the tree and are overgrown by the cambium. Should conditions be, or become, favorable for the larvae and unfavorable for the tree, the larvae develop rapidly and destroy the cambium.

Although this insect can kill trees weakened by dwarf mistletoe, root disease or climatic stress, its primary importance is rendering trees increasingly susceptible to bark beetles. In southern California this species is often the dominant tree killer of drought stressed Jeffrey pine.

Xylotrechus albonotatus, a roundheaded borer in fir

X. albonotatus (referred to in some older literature as X. abietis) is a stout, mid-sized cerambycid, highly variable in size, reported as 10-18 mm for males and 12-20 mm long for females by Linsley (1964). The antennae are relatively short, barely reaching the elytra (the hard forewings of the beetles). The integument is black, and the beetles are covered with white, grayish, or yellowish hairs, creating striking gray and black patterns. This species infests white and California red fir and occurs in the Sierra Nevada south to San Pedro Martir in Baja California (Keen 1949).

X. albonotatus primarily attackes dead, injured, and down trees. Its economic impact lies in the damage it does to sawlogs through its tunnelling activity in the wood.

Eucrossus villicornis, a roundheaded borer in pine

E. villicornis is a much less spectacular insect than X. albonotatus. The beetles are medium brown, elongate, with papery elytra. The large, pincer-like mandibles can easily be seen with the naked eye. A distinctive tooth-like process on each side of the prothorax is also clearly visible, particularly on larger specimens, as are the spines on the apices of the elytra and some of the antennal segments. E. vilicornis flies at night and is attracted to lights. Adults are 16-26 mm long, and the antennae are slightly longer than the body in males, and somewhat shorter in females (Linsley 1962).

E. villicornis has been found in Nevada, California, Arizona, New Mexico, and northern Mexico (Sonora), and infests several species of pine, including ponderosa and Jeffrey. The larvae feed in the phloem of dead or dying trees and tunnel into the wood to pupate (Wickman and Seminoff 1968). It is the latter boring activity which damages the lumber prior to milling.

Wickman and Seminoff (1968) reared this insect from Jeffrey pine logs obtained from Idyllwild, CA. These logs were from trees previously killed by the California flatheaded borer, Melanophila californica.

Dicerca tenebrosa, a flatheaded borer

D. tenebrosa is illustrated in Furniss and Carolin (1977), p. 254, fig. 150E. These beetles are stout, medium sized flatheaded borers. The prothorax and elytra are highly sculptured. The two specimens reared are 17 and 18 mm long, and are a dull metallic bronze on the dorsum and a metallic purplish color beneath. The elytra are drawn out into a point, as shown in the figure (cited above) in Western Forest Insects.

Larvae are reported to feed in the phloem and wood of dead and dying trees, including Pinus, Abies, Picea, and Pseudotsuga menziesii. This species is distributed across North America and is not considered a forest pest.